PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : G10C 3/16, 3/22

A1

(11) International Publication Number: **WO 00/54248**

(43) International Publication Date: 14 September 2000 (14.09.00)

(21) International Application Number: PCT/NL99/00809

(22) International Filing Date: 27 December 1999 (27.12.99)

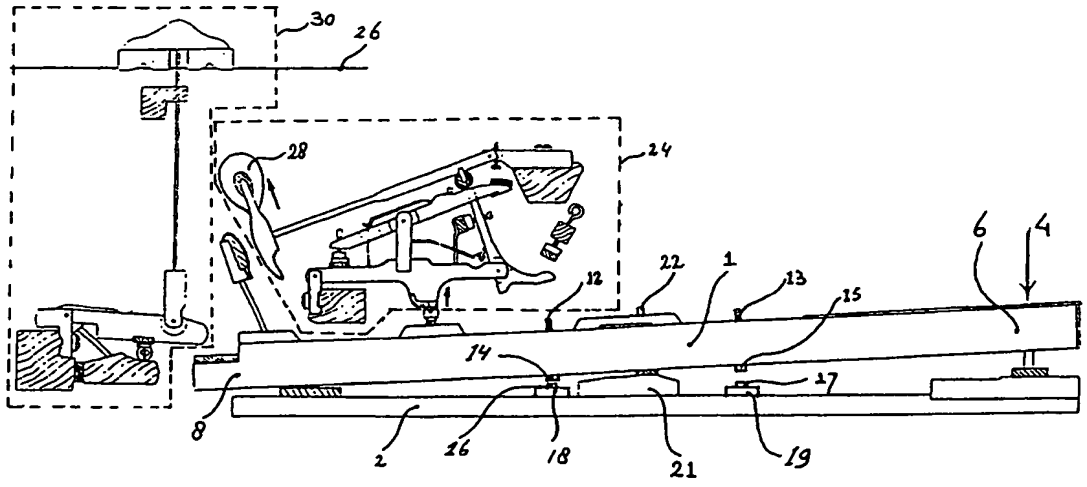
(30) Priority Data:
1011484 8 March 1999 (08.03.99) NL

(71)(72) Applicants and Inventors: SNEL, Everardus, Alexander, Maria [NL/NL]; Beverweertseweg 2, NL-3985 RD Werkhoven (NL). VELO, Henri, Jan [NL/NL]; Prins Bernhardlaan 68, NL-3738 DR Maartensdijk (NL).

(81) Designated States: JP, KR, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: PIANO PROVIDED WITH A KEY- AND HAMMER MECHANISM COMPRISING PERMANENT MAGNETS



(57) Abstract

To put the key- and hammer mechanism of a piano into movement requires a certain amount of effort from the piano player, which effort is sometimes experienced as annoying. As a solution for this problem it is known to use two mutually attracting magnets to regulate the pressing force, one (15) attached to the key and the other (17) thereunder. According to the present invention a second pair of magnets (14, 16) is provided for each key, attached at the other side of the rocking point of that key, to achieve a desired key characteristic. By making the distance between the magnets of each pair of magnets adjustable, the key characteristic can be approximated sufficiently close. Moreover it is possible to change the characteristic of a group of keys (for example only the bass keys) collectively by only one adjustment operation, by mounting the bottom magnets to an adjustable rail.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

Piano provided with a key- and hammer mechanism comprising permanent magnets.

The present invention concerns a piano provided with a key- and hammer mechanism which comprises a number of keys 1, which keys are attached to a frame 2 and which by influence of a pressing force 4 are rockable with respect to the frame, which key- and hammer mechanism further is provided with regulating means for regulating the pressing force, containing a first and second magnet 17,15 for each key, which first magnet 17 during playing the piano has a fixed position with respect to the frame 2 and which second magnet 15 has a fixed position with respect to the relevant key 1, wherein both magnets 15,17 are positioned in such a way with respect to each other that by pressing down the relevant key 1 they exercise a force upon each other.

Such piano is known from the U.S. patent, No. 3,680,426.

In general a key- and hammer mechanism of a piano contains a number of keys which are attached to a frame. By pressing the end of a key, this key rocks with respect to the frame, as a result of which the other end of the key activates further parts of the mechanism by which action a hammer eventually hits a string or a set of strings belonging to one tone, as a result of which the desired sound of the piano is produced. To put the further parts of the mechanism into movement requires a certain amount of effort from the piano player, what is experienced as annoying, specially for long or fast playing.

In the said U.S. patent a piano is described in which means are provided for regulating the pressing force for mitigating this drawback, which regulating means are embodied as a set of two magnets for each key, where a first magnet has a fixed position with respect to the frame and a second magnet has a fixed position with respect to the key.

Both magnets are positioned opposite to each other and attract each other. At the other end of the key a leaf spring is mounted in such a way that it counteracts the force the magnets exercise upon the key. So the total force applied upon the key is determined by the forces of both magnets on the one hand counteracting the force of the leaf spring on the other hand.

With this known assembly it is achieved that the effort required for pressing down the key is decreased. In this assembly however it is not possible or only with great difficulty to adjust a desired key characteristic, the characteristic being defined as the pressing force as a function of the key position. Moreover the key characteristic of the known key- and hammer mechanism is also determined by the leaf spring, which is liable to wear because it is in contact with the key and by the frequently repeated distortion the force of the spring changes in time. Therefore readjustment of these known regulating means is necessary at certain time intervals, which is detrimental.

It is an object of the present invention to provide a key- and hammer mechanism of the type as defined in the preamble in which the key characteristic can easily be adjusted to a large extend according to a desired key characteristic.

Thereto the piano in accordance with the present invention is characterized in that the regulating means further contain a third and fourth magnet 16,14, which third magnet 16 during playing of the piano has a fixed position with respect to the frame 2 and which fourth magnet 14 has a fixed position with respect to the relevant key 1, wherein the third and fourth magnets 16,14 are positioned in such a way with respect to each other that by pressing down the relevant key 1 they exercise a force upon each other, which force is opposite to the force exercised by the first and second magnet 17,15 upon each other.

The mutual force which two magnets placed in their neighbourhood exercise upon each other, like a first and second magnet, increases more than proportionally when the mutual distance between the magnets decreases. This increase

in force can be compensated for a large extent by the mutual force which the second pair of magnets (being composed of the third and fourth magnets) exercise upon each other. Moreover, it is possible to choose the position of the magnets in such a way, that the torque exercised by this pair of magnets is larger or just smaller than the torque of the first pair of magnets. This is for example possible by placing the second pair (one magnet of which is mounted in the key and the other thereunder) at a larger respectively smaller distance from the fulcrum of the key. Furthermore it provides the possibility to choose a different mutual distance of both magnets of each pair of magnets when the key is pressed halfway down. These two variables offer the possibility to achieve a high degree of flexibility in adjusting the desired key characteristic.

In a preferred embodiment of the present invention at least one of the magnets is implemented as a permanent magnet. Permanent magnets of an appropriately chosen material do have the advantage, that their magnetic behaviour hardly changes in time and is almost temperature independent, despite the intensity of use.

In a another preferred embodiment of the present invention the second and/or fourth magnet are attached to the body of the relevant key. When a bore is made in the key, hardly additional space is required to mount the magnet in the key, having the advantage that the present invention specially can be implemented in instruments of an existing design.

In a still further preferred embodiment of the present invention the second magnet (15) is attached to the end (6) of the key intended for pressing down, the fourth magnet (14) is attached to the other end (8) of the key, the first magnet (17) is attached to the frame (2) and below the second magnet (15), and the third magnet (16) is attached to the frame (2) and below the fourth magnet (14).

In this way a straightforward placing of both pair of magnets is achieved, by which the mutually exercised force of one pair is opposite to the mutual force of the other pair. By choosing the distance of each pair of magnets from the

fulcrum of the key and the mutual distance of the magnets of each pair, the desired key characteristic can be approximated to a large extend.

In yet another embodiment of the present invention the piano is provided with means for adjusting the position of the first and/or third magnet with respect to the frame. This measure offers the possibility to change the key characteristic for a number of keys simultaneously with only one adjustment operation, by changing the position of the magnets connected to the frame in the same way. Moreover an adjustment from outside, that is to say without the necessity to do adjustments in the interior of the piano, is easily possible.

In an other embodiment of the present invention in which the above mentioned possibilities are utilized, the means for adjusting the position of the magnets include a rail, on which the magnets to be adjusted are attached and being provided with means to adjust the position of the rail. After manufacturing the key- and hammer mechanism, by which the mutual position of the magnets is determined, after installing the mechanism in the piano the adjustment of the entire mechanism can be adapted to the wishes of the user, who for example prefers a more lighter touch than average or a heavier touch than average. In this case there is no need to do this for every key separately, but it can be done in one operation for all keys of the piano together or for a large part of keys together, by moving the rail with the magnets to be adjusted in preferably vertical direction.

In a further embodiment of the present invention in which the above mentioned possibilities are utilized the means for adjusting the position of the rail are embodied by control means for adjusting the position of the rail, to be operated from outside the housing of the piano. With this measure it is made possible to adjust the key characteristic by the user of the piano himself. For example, it is imaginable that a piano player at the start of studying a piano composition will adjust a key characteristic with a light touch and after achieving a better mastering of the composi-

tion will switch over to a heavier touch. With the said measure this can be done by the piano player himself without intervention of a piano technician.

In a still further embodiment of the present invention the mutual rest positions of two opposite magnets of a key is different from the mutual rest positions of two opposite magnets of an other key. For many piano players it is attractive not to change the key characteristic for every key in the same way, but for example to change the bass tones in a different way compared with the treble tones. In this case the section of the lower tones of the piano can be provided with a first rail for changing simultaneously all the keys belonging to the bass section and with an other rail, independent of the first rail, for changing simultaneously all the keys belonging to the treble section of the piano.

The present invention will be described with reference to the Figures, in which similar elements are indicated with the same reference numbers. Therein:

Figure 1 shows a schematic representation of a preferred embodiment of a key- and hammer mechanism for use in a grand piano according to the present invention;

Figure 2 shows a schematic representation of an other embodiment of a key- and hammer mechanism for use in a grand piano according to the present invention;

Figure 3 shows a key- and hammer mechanism for use in a grand piano with a rail the vertical position of which is adjustable through control means, according to the present invention.

Figure 1 shows a key- and hammer mechanism for one key, which can be used in a grand piano. The key- and hammer mechanism as shown in this figure contains a key 1 rockable with respect to frame 2 of the piano about a balance pin 22, mounted on a support 21. In this way the place where key 1 contacts the support 21 forms the rocking point where it is possible for the key to rock, by pressing down the key.

Below part 6, intended for pressing down the key,

a first permanent magnet 17 is attached to support 19, which preferably has the shape of a rail, underpassing a number of adjacent keys. In part 6 intended for pressing down the body of key 1 a second permanent magnet 15 is mounted, in such a way that the magnets 15 and 17 are opposite to each other and on such mutual distance that they can exercise a force upon each other. In the case of magnets 15 and 17 this is an attracting force.

Below the other part 8 of the key a third permanent magnet 16 is attached to a support 18, which preferably also has the shape of a rail, underpassing a number of adjacent keys. At the end 8 of the body of key 1 a fourth permanent magnet 14 is mounted in such a way that the magnets 14 and 16 are opposite to each other and at such a mutual distance that they can exercise a force upon each other. In the case of magnets 14 and 16 this is a repellent force.

The magnets 14 and 15 mounted in the body of the key are each attached to an adjusting screw 12 and 13 respectively, so the air gap between the pair of magnets 14 and 16 and the pair 15 and 17 respectively, can be adjusted individually. This adjustment can be done as follows: pressing down the key halfway, the air gap between both pairs of magnets are made equal with the help of a feeler gauge. After that, starting from the rest position of the key giving both adjustment screws the same displacement, the touch weight can be adjusted with the help of a weight placed at the end of the key with a weight equal to the required touch weight.

By pressing down the end part 6 of key 1 the key rocks at the said rocking point at support 21, as result of which end part 8 is lifted. This end part actuates the other parts 24 of the key- and hammer mechanism in a way known in itself in the direction of the arrow as depicted, so finally the string 26 is struck by the hammer 28. End part 8 of a damper mechanism 30 is also actuated in a known way to make string 26 vibrate; this damper mechanism is not of essential importance for the present invention.

When a substantially constant touch weight is

required in dependence on the extend the key 1 is pressed down, the air gaps between magnets 15 and 17, and 14 and 16 respectively have to be equal when the key 1 is pressed down halfway. The size of the air gaps can be adjusted by means of the adjusting screws 12 and 13 in such a way that the pressing force has the required value. When key 1 is in its rest position as shown in figure 1, the air gap between magnets 15 and 17 is enlarged compared to the situation where the key is pressed down halfway, so the attracting force between these magnets is decreased. This decrease is compensated for because the distance between the magnets 14 and 16 is equally decreased, as a result of which the repellent force is increased. When key 1 is in the position of being entirely pressed down the opposite situation occurs. When the pair of magnets have the same magnet force and are positioned at equal distances from the balance pin 22, the result is that the required playing force is nearly constant. Also it is recommendable to place the pair of magnets 15 and 17 respectively 14 and 16 as close as possible to the rocking point.

In the case a pressing force is required which is dependent of the extend the key is pressed down, the air gaps between the magnets 15 and 17, and 14 and 16 respectively have to be made different when key 1 is in the position halfway down. This is possible for every individual key by means of the adjustment screws 12 and 13; but it is also possible to obtain this for a group of keys simultaneously by moving rail 18 and/or rail 19 in a vertical direction. The same effect can also be achieved by moving the rails in a horizontal direction. In this way the magnitude of the pressing force and the pressing force in dependence of the extend in which the key is pressed down can be adjusted as desired . The material of the rails is preferably a non - ferromagnetic one like wood, copper, aluminium or a synthetic material.

At the part of the keyboard of the treble section often the pressing force is less than wanted by the piano player. In this case an additional weight can be mounted at the back of the key to allow the use of magnets as described

before. Because of the fact that the compensation required at the treble section of the keyboard is smaller compared to that of the bass section, it is possible to use less stronger magnets at the treble section.

Due to possible mutual influence of the magnets of two adjacent keys it is preferred to place similar adjacent magnets in such a way that they show an opposite direction of magnetisation. This means for example if a magnet 14 belonging to a key has its north pole on top, the adjacent magnets on either side have their south poles on top. Of course this applies also for magnets 15, 16 and 17.

It has to be noticed that the present invention is described on the basis of the white keys of a piano. As is well known, a piano has also black keys, the rocking point of which is shifted with respect to the rocking point of the white keys.

As a result of this there are four magnet rails at the frame for each group of keys, which preferably are independently adjustable.

At the treble side of the keyboard however the two rails at the front side can be combined to one rail, just as the rails at the back. Only the situation concerning the white keys is described in the present description of the figures.

In figure 2 an other embodiment of the key- and hammer mechanism according to the present invention is shown. Compared to figure 1, in this figure 2 the magnets 14 through 17 and the accompanying adjusting screws 12 and 13 have been deleted, like the rails 18 and 19. In figure 2 the magnets for the regularization of the pressing force are mounted on top of key 1. Near to the rocking point a support 23 is attached to the key, on which support a cylindrically shaped magnet 32 is attached. Opposite to the pole ends of this cylindrical magnet a magnet 27 and a magnet 31 are mounted. These magnets 27 and 31 are connected to the frame of the piano by means of rail shaped supports 25 and 29. The direction of magnetisation and the position of each of the magnets 27, 31 and 32 is chosen in such a way, that the magnets 27 and 32 exercise a mutually attracting force and that the magnets 32 and 31 exercise a mutually repellent

force upon each other.

The magnets 27 and 31 connected to the frame each are connected to adjustment screws 26 and 33 respectively, such the air gap between the pair of magnets 27 and 32 and the pair 31 and 32 respectively can be adjusted individually. Preferably this adjustment is carried out in a way as already described with reference to figure 1. By shifting the rail 25 and/or 29 preferably in horizontal direction a change of position for a group of magnets 27 and/or 31 can be achieved, so the magnitude of the pressing force and the pressing force in dependence of the extend the key is pressed down, can be adjusted as desired, as is described already, with reference to figure 1.

In figure 3 an embodiment of the key- and hammer mechanism according to the present invention is shown, provided with a rail to support the magnets connected to the frame, the vertical position of which is adjustable by means of control means for controlling from outside the housing of the piano, so the adjustment can be easily carried out by the piano player himself.

In this figure rail 18 for each key is provided with a magnet 16. This embodiment of the present invention being described for the pair of magnets 14,16, it should be understood that this embodiment also can be applied on the pair of magnets 15,17. In this embodiment rail 18 pops through the supporting part of frame 2; the underside of rail 18 is chamfered and rests upon the also chamfered, wedge shaped slide piece 34 what is moveable to and fro in horizontal direction according to the direction of arrow 38 over a fixed part 36 of the frame of the piano. Rail 18 is resting upon and remains in contact with slide piece 34 by gravity; if necessary rail 18 can be pressed against slide piece 34 by means of a spring. (not shown in the figure) By moving slide piece 34 according to the direction of arrow 38 rail 18 is moved vertically so that the stationary distance between magnets 14 and 16 (see figure 1) can be reduced or enlarged.

The to and fro movement of slide piece 34 takes place by slide piece 34 being connected to a revolving shaft

40. The attachment of shaft 40 to slide piece 34 is in such a way that the shaft is revolving freely but not moveable in relation to the slide piece. The shaft 40 is over its length partly provided with external screw thread 42 which part of the shaft provided with screw thread goes through a block 44 provided with internal screw thread, which block immovable is attached to a fixed part of frame 36 of the piano. The end of shaft 40 sticks out of the housing 46 of the piano and is provided with a control knob 48, in such a way that it is possible to adjust the position of the rail from outside the housing of the piano, in particular from the place of the piano player, so the player himself can adjust the key characteristic to his wish.

It should be remarked that, the examples of embodiments of the present invention being described with reference to a grand piano this invention also can be applied in all kinds of musical instruments where a key- and hammer mechanism is used to strike strings.

Claims

1 Piano provided with a key- and hammer mechanism which comprises a number of keys (1),

- which keys are attached to a frame (2) and which by influence of a pressing force (4) are rockable with respect to the frame,

* which key- and hammer mechanism further is provided with regulating means for regulating the pressing force, containing a first and second magnet (17,15) for each key, which first magnet (17) during playing the piano has a fixed position with respect to the frame (2) and which second magnet (15) has a fixed position with respect to the relevant key (1),

- wherein both magnets (15,17) are positioned in such a way with respect to each other that by pressing down the relevant key (1) they exercise a force upon each other,

characterised in that
the regulating means further contain a third and fourth magnet (16,14), which third magnet (16) during playing of the piano has a fixed position with respect to the frame (2) and which fourth magnet (14) has a fixed position with respect to the relevant key (1),

- wherein the third and fourth magnets (16,14) are positioned in such a way with respect to each other that by pressing down the relevant key (1) they exercise a force upon each other, which force is opposite to the force exercised by the first and second magnet (17,15) upon each other.

2 Piano according to claim 1 in which at least one magnet is implemented as a permanent magnet.

3 Piano according to claim 1 or 2 in which the second and/or fourth magnet (15,14) are attached to the body of the relevant key (1).

4 Piano according to anyone of the claims 1-3 in which the second magnet (15) is attached to the end (6) of the key intended for pressing down, the fourth magnet (14) is attached to the other end (8) of the key, the first magnet (17) is attached to the frame (2) and below the second magnet (15) and the third magnet (16) is attached to the frame (2) and below the fourth magnet (14).

5 Piano according to anyone of the preceding claims, provided with means (18,34,40,42,44,48) for adjusting the position of the first and/or third magnet (17,16) with respect to the frame (2).

6 Piano according to claim 5 in which the means for adjusting the position of the magnets include a rail (19,18) on which the magnets (17,16) to be adjusted, are mounted and provided with means (18,34,40,42,44,48) for adjusting the position of the rail.

7 Piano according to claim 6 in which means (18,34, 40,42,44,48) for adjusting the position of the rail (19,18) are embodied by control means (40,42,44,48) for adjusting the position of the rail, to be operated from outside the housing of the piano.

8 Piano according to anyone of the claims 5-7 in which the mutual rest positions of two opposite magnets of a key is different from the mutual rest position of the two opposite magnets of an other key.

9 Key- and hammer mechanism as defined in anyone of the preceding claims.

10 Piano key with a rocking point for attaching this key rockable to the frame of a piano, provided with at least two permanent magnets on either side of the rocking point.

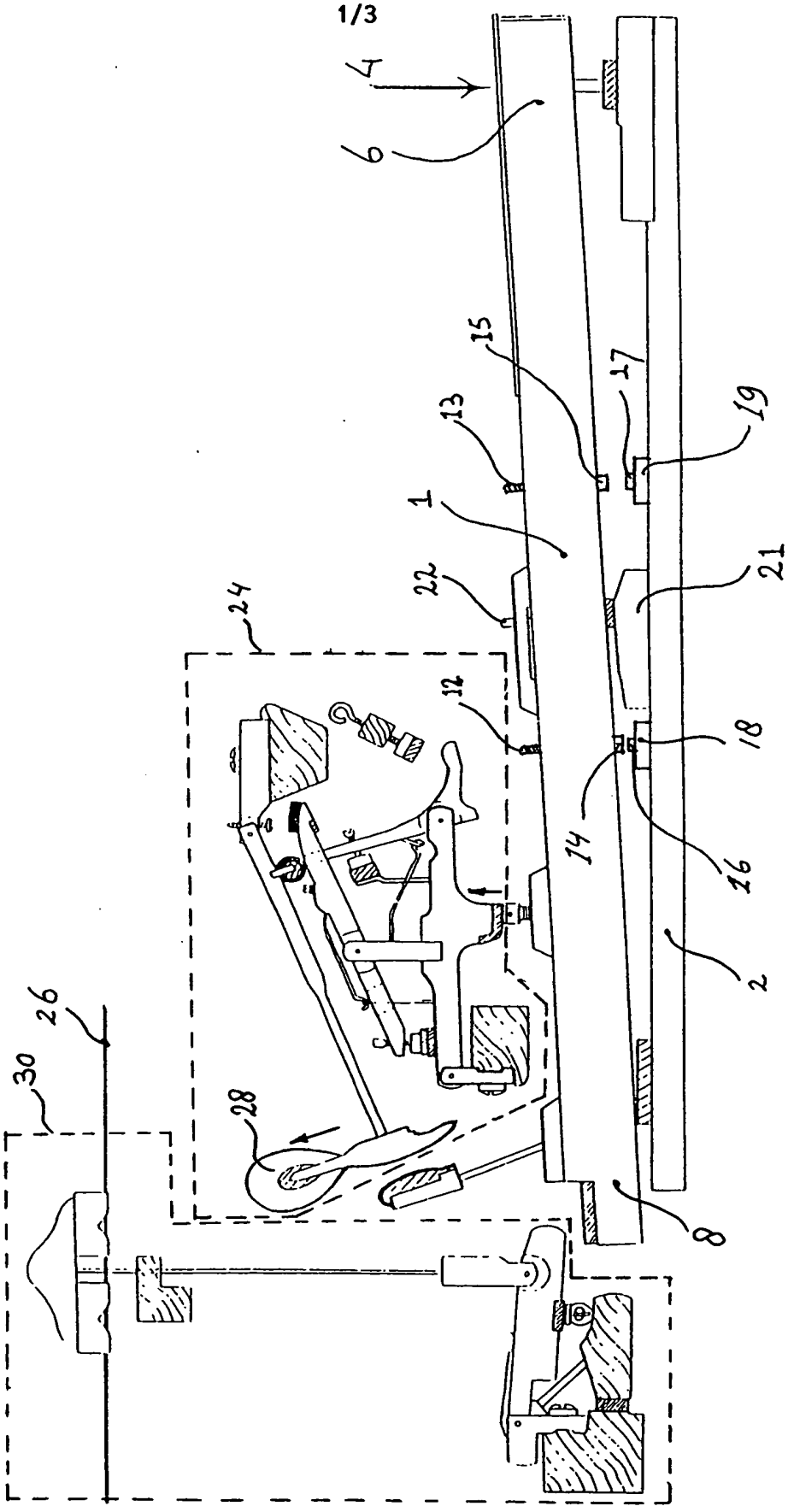


Fig. 1.

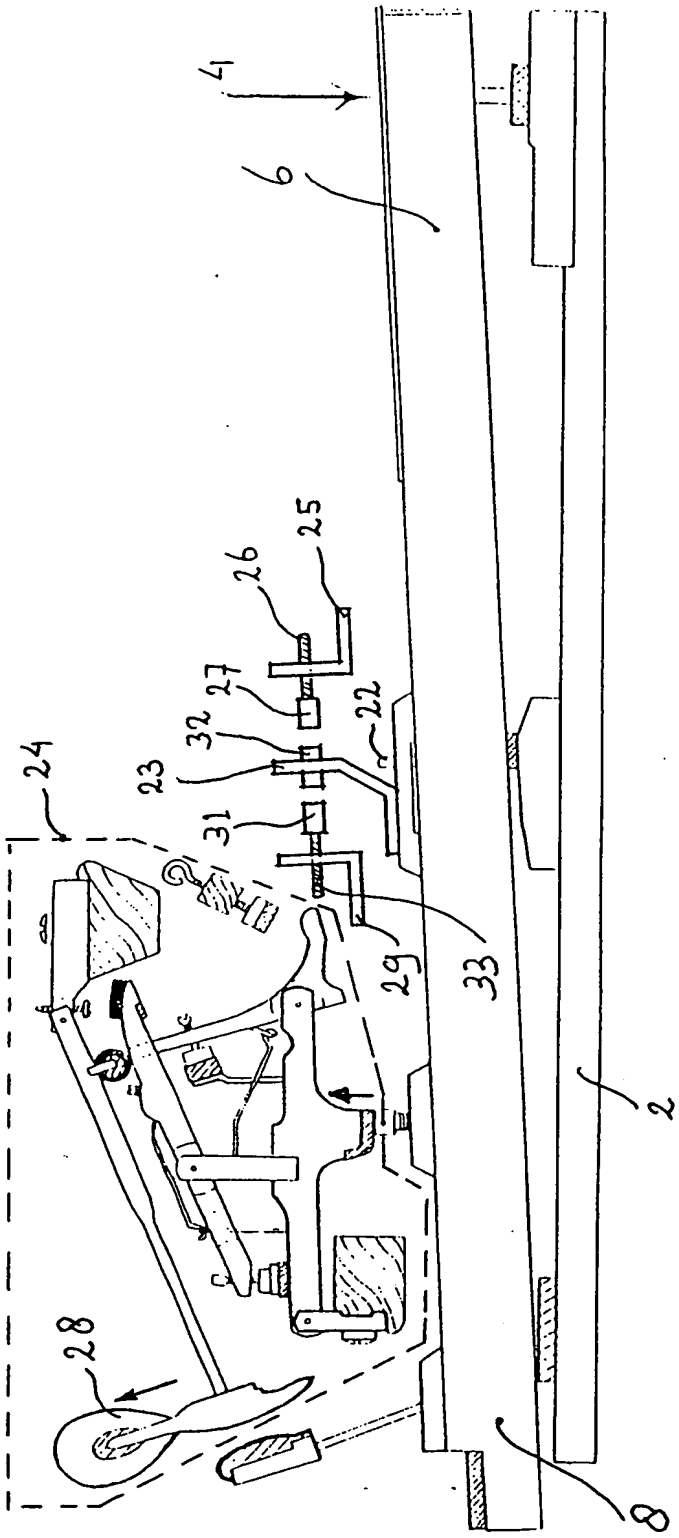


Fig. 2

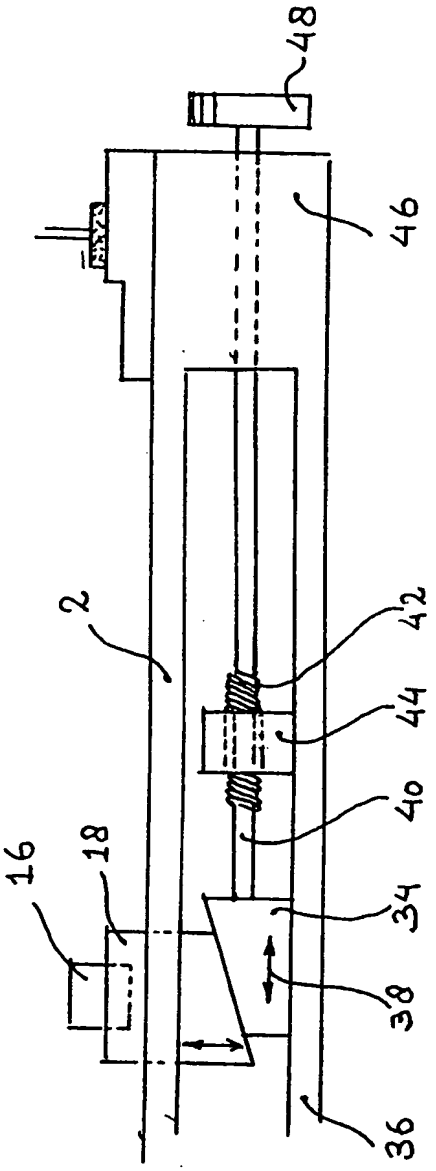


Fig. 3

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/NL 99/00809

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G10C3/16 G10C3/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G10C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal WPI PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 92 19 068 U (HERMANN ULRICH) 24 July 1997 (1997-07-24) page 2, line 25 - line 32; figure 5	1-5,9,10
A	WO 98 10409 A (PETERSEN ERIK INGVOR) 12 March 1998 (1998-03-12) page 10, line 9 - line 24	1-5,9,10
A	US 3 680 426 A (FRY EARL E) 1 August 1972 (1972-08-01)	
A	US 5 763 799 A (KIMBLE THOMAS E) 9 June 1998 (1998-06-09)	
A	DE 19 53 267 A (BACHLX F;BACHL A) 6 May 1971 (1971-05-06)	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 May 2000	06/06/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Swartjes, H

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter nal Application No
PCT/NL 99/00809

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 9219068 U	24-07-1997	DE 4223739 A	20-01-1994
		AT 160463 T	15-12-1997
		CZ 282808 B	15-10-1997
		DE 4304807 A	18-08-1994
		DE 59307689 D	02-01-1998
		EP 0567024 A	27-10-1993
WO 9810409 A	12-03-1998	EP 0923772 A	23-06-1999
US 3680426 A	01-08-1972	NONE	
US 5763799 A	09-06-1998	NONE	
DE 1953267 A	06-05-1971	NONE	